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by John R. Baldwin, Desmond Beckstead and Richard Caves

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John R. Baldwin *
Desmond Beckstead **
Richard Caves ***

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Micro-Economic Analysis Division
24-B R.H. Coats Building, Ottawa, K1A 0T6
Statistics Canada
Facsimile Number: (613) 951-5403

*(613) 951-8588
Email: baldjoh@statcan.ca

**(613) 951-6199
Email: beckste@statcan.ca

*** Department of Economics
Harvard University

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The authors' names are listed alphabetically.

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Aussi disponible en français

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Abstract

This paper studies changes in diversification of firms and plants since the early 1970s in the Canadian manufacturing sector. It finds that there has been a general increase in specialization of both firms and plants. Firms have been continuously reducing the span of industries in which they operate, particularly when the industries are unrelated. Commodity specialization has also occurred at the plant level; however, in contrast to industry specialization, the pace of commodity specialization emerged late in the period, around the time of implementation of the Free Trade Agreement between Canada and the United States. Plant specialization increased most in those plants that moved most strongly into export markets.

Keywords: diversification, trade

JEL codes: 611

Executive Summary

This study asks whether there are discernible patterns to changes in diversification of manufacturing firms and plants over the last quarter century. It also asks whether changes in diversification (or changes in specialization) are coincident with changes in Canada's trade environment.

The first part of the study examines whether firms have changed the extent to which they diversify across industries (whether they have plants and production located in more than one industry). Industry diversification takes advantage of synergies across industries or exploits firm-level scale economies. It may also facilitate anti-competitive practices. Two measures of firm diversification are used in this study. The first is the magnitude of multiplant operations. The second is a measure of the extent to which the production of a firm takes place in more than one industry.

The second part of the study focuses on plant-level specialization—the extent to which plants produce a small or a large number of commodities. For a given volume of sales, plants with fewer commodities will have longer production runs and will be more able to exploit product-line scale economies. The measure of plant level diversification used here captures the extent to which output of a plant is spread across multiple commodities.

We ask three questions:

1) Are there distinct cycles in changes in firm-level diversification that reflect discontinuous merger booms or has specialization increased gradually as the size of the Canadian market has increased?

The firm-level diversification measure that captures the extent to which a firm's production is distributed across industries declines more or less continuously over this period. On this basis, we conclude that diversified Canadian manufacturing firms have retrenched and concentrated their production in fewer industries. This probably reflects the gradual increase in the size of the markets, both domestic and foreign, served by Canadian firms.

Firms have tended to decrease the extent to which they diversified across unrelated industries (different 2-digit industries) more than they reduced related diversification (across 4-digit industries within 2-digit industries). This accords with the argument that there are fewer synergies contained in unrelated diversification.

When the number of plants per multiple-plant firm is used as a diversification measure, the trend to firm-level cross industry specialization starts later (1988). The difference in the timing of the decline shown by each of the two measures indicates that firms gradually increased the degree to which they specialized their sales in one industry throughout the period, but by the late 1980s, secondary plants had become sufficiently peripheral to core activities that they were discarded.

2) Has plant level commodity specialization followed the same trend?

Plant level specialization has also increased monotonically over the period. But in contrast to firm-level diversification, the decrease in plant level diversification has a discontinuous break around the time of the Free Trade Agreement between Canada and the United States. Product line specialization increased dramatically just before the FTA and this increase continued well into the 1990s. As a result, product-run length within plants increased dramatically over the period before and after the FTA. The evidence shows that product specialization increased more than industry level specialization in the late 1980s.

3) Was the increase in plant specialization related to trade liberalization?

To examine this issue, we use panel data on plants to investigate the relationship between product-line specialization and the export intensity of individual plants. We find a strong relationship between the export intensity of a plant and its specialization. Plants that export more of their sales are likely to be more specialized. Moreover, during the transition period from the late 1980s to the early 1990s, those plants that increased their export intensity increased their plant specialization. Foreign-controlled plants that did little exporting were less specialized than domestic plants before the implementation of the FTA, but became more so after the agreement. This evidence supports the hypothesis that trade liberalization caused plants to specialize in fewer products.

1. Introduction

This paper examines diversification trends in the Canadian manufacturing sector over the period stretching from the 1970s to the mid 1990s. The study focuses first on the extent to which firms operate in more than one industry. It then examines the degree to which plants produce more than one product.

The extent to which firms diversify across industries is of interest because of its connection to merger activity, changes in aggregate concentration and the concern that is paid to the extent and importance of conglomerate mergers.[1] By contrast, changes in diversification of plants across commodities reveal how firms have adapted multi-product production to the presence of scale and scope economies at the plant level.

a) Firm Diversification

Changes in diversification at the firm level may simply be a manifestation of a long-run phenomenon that reflects the increasing trend toward specialization on which Adam Smith focused our attention in the Wealth of Nations. Stigler's (1951) admonition that the degree of specialization is a function of the size of the market suggests that the level of diversification of firms in Canada should have had a secular decline over much of the last quarter century, since the Canadian domestic market grew during this period. In addition, a secular decline in American tariffs caused growth in the foreign market served by Canadian firms.

Public policy has been leery of the growth of large conglomerate firms that control resources across a far-flung empire, both for fear of political consequences and for economic reasons.[2] Negative economic effects are seen to arise from the anticompetitive consequences of specific types of behaviour (predatory pricing) that is facilitated by the 'deep-pockets' of large firms (Clarke, 1985). However, many economic studies have dismissed conglomerate forms of organization as basically unworkable (see Royal Commission on Corporate Concentration, 1975). Merger waves that lead to increases in aggregate concentration are seen to be self-correcting; the undue enthusiasm for this form of corporate expansion that emerges occasionally, it is argued, will be reversed by well functioning capital markets that should eventually cause firms to divest activities that do not fit well with their core capacities.[3]

Although diversification across unrelated industries (those that do not have marketing or production synergies with the core industry to which the diversifying firm belongs) is seen to be relatively unprofitable[4] and therefore likely to be relatively uncommon, diversification of firms

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[1] See Federal Trade Commission (1972), Royal Commission on Corporate Concentration (1978), Caves (1987).

[2] See Edwards (1955), Bain (1968), and the Royal Commission on Corporate Concentration (1978) for discussions of the effects of conglomerate mergers that focus as much on the political as the economic consequences of these mergers.

[3] For a review, see Montgomery (1994).

[4] See Lecraw (1977, 1984) and the Royal Commission on Corporate Concentration (1978) for Canadian evidence.

into closely related product lines or across vertically integrated stages of the production process is regarded as being likely to yield more benefits (Rumelt, 1974, Montgomery, 1994).

While general agreement exists about the advantages of related as opposed to unrelated diversification, the extent to which the benefits and the extent of different types of diversification have changed over time is less well understood (Montgomery, 1994). Discerning long-run trends is made difficult by the emergence of merger booms[5] and the short-run focus of many studies. This study examines trends in the level of firm and plant-level diversification that have occurred in Canada over the last quarter century—in order to ascertain whether there has been a trend in one direction or another and to examine the extent to which changes in the level of diversification are related to increasing trade liberalization.

b) Product Diversification at the Plant Level.

This paper also examines a related phenomenon—the diversification of plants across product lines. Diversification by firms across industries is ultimately part of a process that leads firms to produce and market more than one product. This may, but is not necessarily, accomplished by producing more than one product at the plant level.

Changes in the magnitude of plant-level diversification arise from firms' attempts to adapt to changes in underlying production economies. Traditionally, the importance of product-line scale economies provided the foundation for studies of plant specialization. Failure to fully exploit scale economies in the product line was seen to result from high transportation costs (e.g., Scherer et al., 1975) that arose from constraints arising from geographical distance between markets or from tariffs that exacerbated the effects of distance (Eastman and Stykolt, 1967). Baumol et al. (1982) emphasize that scope economies at the plant level can also cause firms to choose to produce multiple products, since the economies of joint production could offset the costs of not exhausting scale economies for each product line.

A study of the level of diversification of plants and changes therein reveals whether the relative importance of these two forces has been changing. It is particularly important in the Canadian context since major changes in trade policy in the late nineteen eighties allow us to examine whether changes in trade policy were associated with changes in plant specialization that led firms to produce a narrower range of products. In the late 1980s, Canada underwent a dramatic change in its trading environment—with the advent of the Free Trade Agreement with the United States. This treaty not only moved to eliminate tariffs but also set in place an arbitration procedure that was meant to assure firms of a more stable trading environment.

Economists have made reference to different models to suggest that trade liberalization might be expected to affect production efficiency. The Eastman and Stykolt (1967) model of foreign investment stressed that tariff barriers in a small country with oligopolistic markets could lead to suboptimal plant size. Associated with problems of suboptimal plant size were difficulties arising

[5] See Scherer (1971) or Brown and Rosengreen (1987) for a discussion of these booms.

from short production runs. Harris (1984) formalizes a general equilibrium model that examines the effects of trade liberalization on the production process.[6]

Empirical studies by Daly et al. (1968) and Caves (1975) argued that Canadian plants suffered from excessive levels of diversity. Operating behind tariff barriers, Canadian plants were seen to have had production runs that were too short to exploit the economies of large-scale production.

Based on this framework, both the Economic Council (1967, 1975) and the Royal Commission on Corporate Concentration (1978) predicted that the lowering of Canadian tariff barriers would increase Canadian average plant size and that it would reduce product diversity at the plant level and improve the length of production runs.

c) Background Studies

Despite the general interest in the diversification of firms and plants, there are few empirical studies of diversification because of the difficulty in obtaining comprehensive data on the operations of firms across industries or on the degree of plant specialization. And many of these studies suffer from not having very comprehensive databases or not being able to examine changes over time.

Several classic U.S. studies examine the degree to which firms diversify across industries. Major studies for the United States include those of Gort (1962), Berry (1975) and Rumelt (1974). Gort (1962) draws a sample of 721 enterprises from 1954 U.S. census records that consists of all multi-establishment companies with over 2,500 employees, but he focuses primarily on a sample of 111 of these businesses over the period 1947-54. Rumelt (1974) examines the history of about 250 Fortune 500 companies over the period 1949 to 1969. Berry (1975) focuses on the performance of 460 Fortune 500 companies during the early 1960s. These earlier studies suffer from not having a universe of firms or a measure of diversification that is very comprehensive.[7] More recently, Gollop and Monahan (1991) examine diversification changes in the manufacturing sector over the period 1963-1982, using comprehensive data on products produced from the Census of Manufactures program and a comprehensive diversification index.[8]

Earlier firm-level studies for Canada include McVey (1972), Lecraw (1977), Caves (1975), and Caves et al. (1980). Perhaps the most comprehensive study is by Caves et al. (1980), who use Dun and Bradstreet data to examine about 2,000 firms in both manufacturing and service industries in the mid-1970s; but they had to rely on only a rough ranking of the importance of plants in different SICs to obtain measures of diversification. None of these studies examine the nature of changes in diversification patterns over time.

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[6] There is also an extensive literature that focuses on the effect of trade liberalization on the price-cost margin (Markusen, 1981; Markusen et al., 1995).

[7] Gort (1962), for example, uses the percentage of economic activity in the firm's primary industry of specialization, as well as the number of industries in which the firm operates.

[8] They use a Herfindahl (see Berry 1975) modified to take into account the differences in the input/output structure of the economy to deal with relatedness between industries. The Herfindahl index is the sum of the squares of a firm's output shares in each of the industries in which it operates.

A recent, more comprehensive study (Baldwin, Beckstead and Gellatly, 2000) examines diversification at the firm level in 1998 for the Canadian employer business sector, using the Statistics Canada's Business Register that contains a list of virtually all Canadian firms in both the goods and the service sectors. The study uses data on firms' employment at the plant level to derive an entropy index of diversification that takes into account both the number of industries in which a firm operates and the distribution of production across these industries. The study describes the extent of diversification, whether firms diversified primarily vertically or horizontally, and how industrial diversification patterns were closely associated with certain industry characteristics. But like most previous studies, it focuses on a single point in time.

The one study to examine changes in the diversity of manufacturing plants and its relationship to changes in trade patterns (Baldwin and Gorecki, 1983a) investigates a relatively short time period—a three-year period in the 1970s. In this study, we focus on changes in diversification that have taken place since the early 1970s. We focus on manufacturing since comprehensive and reliable time series data are available for this Canadian sector. Recent research for the United States that examines changes in firm-level diversification in the U.S. manufacturing sector for the quinquennial census years from 1963-1982[9] (Gollop and Monahan, 1991) finds that firm-level diversification increased while at the same time establishments became more specialized.[10] In this study, we examine a longer period and investigate whether similar trends were taking place in Canada. We are particularly interested in whether changes in specialization are related to changes in the trade regime facing Canadian industry.

2. *Diversification across Commodities and Industries*

Product diversification arises when firms choose to produce more than one product.[11] Diversification across the product space can occur in several different ways. Firms may choose to combine different product lines within the same plants, or they may choose to own plants in different industries, with each producing quite different products.

Since diversification occurs in different ways, we focus here on different but complementary measures of diversification. In the first instance, we examine diversity at the firm level. Here we ask how many firms operate more than one plant and whether their production is diversified across industries, defining industries at the 4-digit 1980 SIC level. In the second section, we focus on commodities and examine the extent to which plants and firms produce multiple products.

Examination of changes in diversity at the firm as opposed to the plant level potentially reveals information about the economic forces operating at different levels of the production process. Changes in diversity at the plant level reveal the extent to which economies of product-line specialization have become more important. Increases in the importance of scale economies for

[9] These are 1963, 1967, 1972, 1977, and 1982.

[10] Streitwieser (1991) also examines changes at the plant level, but only for 16 4-digit industries for the years 1972, 1977 and 1982.

[11] Firms may also choose to diversify geographically, but that is not the subject of study herein.

individual products should lead to increased plant-level specialization in a multi-plant firm (Scherer et al., 1975, chapter 5). On the other hand, increases in scope economies related to producing multiple product-lines should increase commodity plant-level diversification. Finally, increases in the importance of scope economies in marketing or in research and development would have lead to increased cross-industry diversification at the firm level, with firms operating more plants producing more commodities across more industries.

There are, therefore, different ways in which firms may diversify. On the one hand, firms may diversify by increasing the number of commodities being produced in each plant. On the other hand, firms can expand to own plants in a more diverse set of industries, with or without changing the number of products they produce per plant.

Firm-level and plant-level diversification need not move in the same direction. Gollop and Monahan (1991) found that product diversification increased in U.S. manufacturing between 1963 and 1982, with the bulk of the increase occurring among establishments (as opposed to within establishments). Firms became more diversified at the same time as their plants became more specialized.

In this study, we examine both firm- and plant-level diversification, focusing on long-term trends in both. In the first section, we develop measures of diversification at the industry level—asking how firms' employment is distributed across industries. In the second, we examine how plants and firms distribute their output across commodities.[12]

3. *Nature of the Data*

The data that are used here to investigate changes in diversification come from a longitudinal data file on all plants in the Canadian manufacturing industry over the period 1973-1997. This longitudinal file is based on data that are derived from both survey and administrative sources that provide plant-level data for the universe of plants in the manufacturing sector. The survey data are derived from long-form questionnaires (generally filled in by the largest plants) that contain the most detailed information, including commodity data, and short-form questionnaires (generally filled in by smaller plants) that are much less detailed. In addition, for the very smallest plants, administrative data on sales and employment come from tax records.

In this data base, a plant's sales are classified to one industry.[13] Each plant is identified as being part of a firm and thus firm-level information on the distribution of its sales by industry is available for the measurement of patterns of diversification across industries. Detailed information at the plant level includes the 1980 SIC, employment, value of shipments and value

[12] We use employment for industry diversification measures to make our results comparable to those reported in Baldwin, Beckstead, Gellatly and Peters (2000). For commodity diversification at the plant level, only sales were available. Redoing the firm diversification indices using sales would not change the results reported herein.

[13] Plant specialization ratios are published to indicate what proportion of the sales of plants in an industry are actually derived from commodities that are classified to that industry.

added. Information at the firm level includes nationality of control, the SIC of the industry to which the firm is classified and aggregate firm size derived from plant-level aggregates.

Since each of the plants in the data base possess a firm-level identifier, firm diversification indices can be calculated by examining the number of manufacturing industries in which the plants of a firm operate and the distribution of the relative importance of a firm's activity in these industries.[14] In this study, each firm is classified to a dominant industry according to its value-added weighted manufacturing activity of all of its plants and its diversification across all industries based on the location of its plants is then calculated.

In addition, annual commodity data are available for all plants that received a long-form (detailed) questionnaire. The survey collects data on the value of shipments and quantity of each commodity produced in the plant. We use these commodity data to calculate an index of diversity across commodities for plants and for firms.

It should be noted that sometimes a multi-plant firm does not report commodity data for all its plants. Therefore, firm commodity data may not be completely representative.[15] We examine whether this creates a problem by grouping the plants for which commodity data are available into different categories based on the type of firms to which they belong—whether the firm is diversified across unrelated or related industries. We then compare the results for each category to see if major differences exist in the changing patterns of diversity. In addition, occasionally we also restrict our interest to just those firms where commodity coverage is complete.

4. Multi-plant Operation as a Diversification Measure

The first measure of diversification used here is the number of plants operated per firm. Diversification across industries is generally higher where multi-plant operations are more common. Firms that produce products that are classified to more than one industry generally do so through multi-plant operations. Single-plant firms are, by the definition used here, single-industry (non-diversified) firms. Multi-plant firms have the potential to be industrially diversified, though it should be noted that some multi-plant firms only operate in one industry.

In the Canadian manufacturing industry, approximately 20% of manufacturing plants belonged to multi-plant firms in 1973. These multi-plant firms comprised 5% of the manufacturing firm universe and accounted for 76% of shipments. The relative importance of multi-plant firms, whether measured as a percentage of all firms or of all shipments, remained relatively constant over the period. The percentage of firms that were multi-plant declined from 5.7% in 1973 to about 4.3% by 1990, while the percentage of plants in multi-plant firms declined from 20.3% to 17.3%. Multi-plant firms accounted for 76% of shipments in 1974 and 74% of shipments in 1993.

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[14] Since the source of data is a manufacturing survey, only manufacturing plants are included. This means that diversification of manufacturing firms outside of the manufacturing industry is not covered here.

[15] The survey is designed with the plant, not the firm population in mind.

The number of multi-plant firms increased over the period from 1973 to 1988 and then held steady in the 1990s (Figure 1). The average number of plants per multi-plant firm also increased up to the late 1980s, but then declined in the 1990s. This measure declined by over 10% since its 1987 peak.

On the basis of this evidence there was a distinct break in the diversity of firms in the manufacturing sector. What was a general movement towards more plants per firm ended in the late 1980s, and then declined more or less continuously into the 1990s.

5. *Changes in Multi-plant Operations*

If we are to use the number of plants operated by a firm as a measure of diversification, we need to better understand the types of diversification that a multi-plant operation represents. A multi-plant firm may own more than one plant but have all of them in the same 4-digit industry; or it may operate plants that span 2-digit industries. The latter involve operations that are less closely related. We address this potential problem with the multi-plant measure by breaking multi-plant operations down into several categories that differ in terms of the degree to which a firm's plants are located in the same, related (the same 2 digit but a different 4 digit), or unrelated industries (different 2-digit industries).

In this section, we examine which type of multi-plant operations have declined during the period when multi-plant operations decreased dramatically. To do so, we examine differences in the distribution of different types of multi-plant firms in 1983 and 1993. In Table 1, we describe the distribution in 1983 and 1993 of firms by four diversification types—those that possessed a single plant, those that possessed multiple plants but whose plants were all in a single 2-digit and a single 4-digit industry, those who occupied a single 2-digit industry but had plants in several 4-digit industries, and those who spanned multiple 2-digit and 4-digit industries.

These categories range from the least diversified to the most diversified. Firms that have only one plant in one industry or those with multiple plants that are located in the same industry are the least diversified. Those that have plants in multiple 4-digit industries within the same 2-digit industry have crossed an industry boundary but the type of diversification is relatively narrow—in that all plants are still within the same 2-digit industry. Those that then cross 2-digit industries are the most diversified—in the sense that that they have moved into industries that are less related.[16] In this paper, we refer to those with plants all within the same 2-digit industry as being diversified into related industries.

Table 1 compares the number of firms in each category in each of the years 1983 and 1993. The row totals indicate the number of firms in each category as of 1983, which are divided into those that die between 1983 and 1993 (column VI) and those that do not do so (columns I to IV). Each of the latter indicates the location of the firm as of 1993. For example, of the 27,135 singles in

[16] We follow the normal practice of presuming that 4-digit industries within a 2-digit industry are generally more closely related than different 2-digit industries. Two food processing industries are more closely related than a food processing and a paper board industry in terms of industrial techniques and the nature of demand.

1983, 15,449 die, 11,502 remain singles and the remainder become multi-plant. On the other hand, the column totals give the number of firms in each category in 1993, divided into those coming from births during the period (row I), and those in various categories in 1983. For example, of the 510 multiple 2 and multiple 4 firms in 1993, some 178 came from births, 217 had been in that category in 1983, 19 had only been single 2 and multiple 4's in 1983.

Since changes that occur in diversity are the result of shifts in status both within the continuing population and the result of changes in the distribution of the various categories due to births and deaths, we examine each in turn to see if the movement to less diversification is evident in both populations.

Differences in the types of activities pursued by entering and exiting firms reveal the underlying advantages of different types of multi-industry operations. If exiting firms are more likely to be multi-plant than are new firms, we can infer that the inherent advantages of operating multi-plants are declining. For it is by birth and death that the population sorts itself out on the basis of efficiency (Baldwin, 1995).

The percentage of deaths in the more diverse categories (multiple 2-digit and/or multiple 4-digit) is greater than the percentage of births in each (Figure 2). Within the continuing firm population, there is a greater tendency for the more diverse firms in 1983 to become less diverse by 1993 than there is for the less diversified firms in 1983 to become more diverse by 1993. For example, some 30% of continuing firms that in 1983 operated across more than one 2-digit industry decreased their diversity by 1993, while only 23% of the original group of firms in this category were renewed by firms that were in a less diverse category and that increased their diversity to begin operating across multiple 2-digit industries. At the other end of the spectrum, some 38% more firms were multiple plant firms in 1983 that moved to become single plant firms by 1993 than did the opposite. Of those with multi-plant operations within the same 4-digit industry in 1983, some 35% became single-plant firms by 1993 but only 14% became more diversified—by adding plants in a new 4-digit or 2-digit industry. Of those plants operating in multiple 4-digit industries in 1983, some 42% became less diversified and only 11% became more diversified.

Table 1. Changes in Diversity Status: 1983-1993

			1993						
		Firm type	Single	Multi					
	Firm type	Sic 80 mix	Single 2 Single 4	Single 2 Single 4	Single 2 Multiple 4	Multiple 2 Multiple 4	Totals from 1993	Firms from 1983 dying by 1993	Total for 1983
			I	II	III	IV	V	VI	VII
1983	Single	Single 2 Single 4 I	11,502	87	30	67	11,686	15,449	27,135
	Multi	Single 2 Single 4 II	110	164	15	29	318	279	597
		Single 2 Multiple 4 III	51	20	82	19	172	107	279
		Multiple 2 Multiple 4 IV	92	24	36	217	369	209	578
		Totals from 1983 V	11,755	295	163	332	12,545	16,044	28,589
		Births since 1983 alive in 1993 VI	14,268	375	92	178	14,913		
		Total for 1993 VII	26,023	670	255	510	27,458		

Figure 1

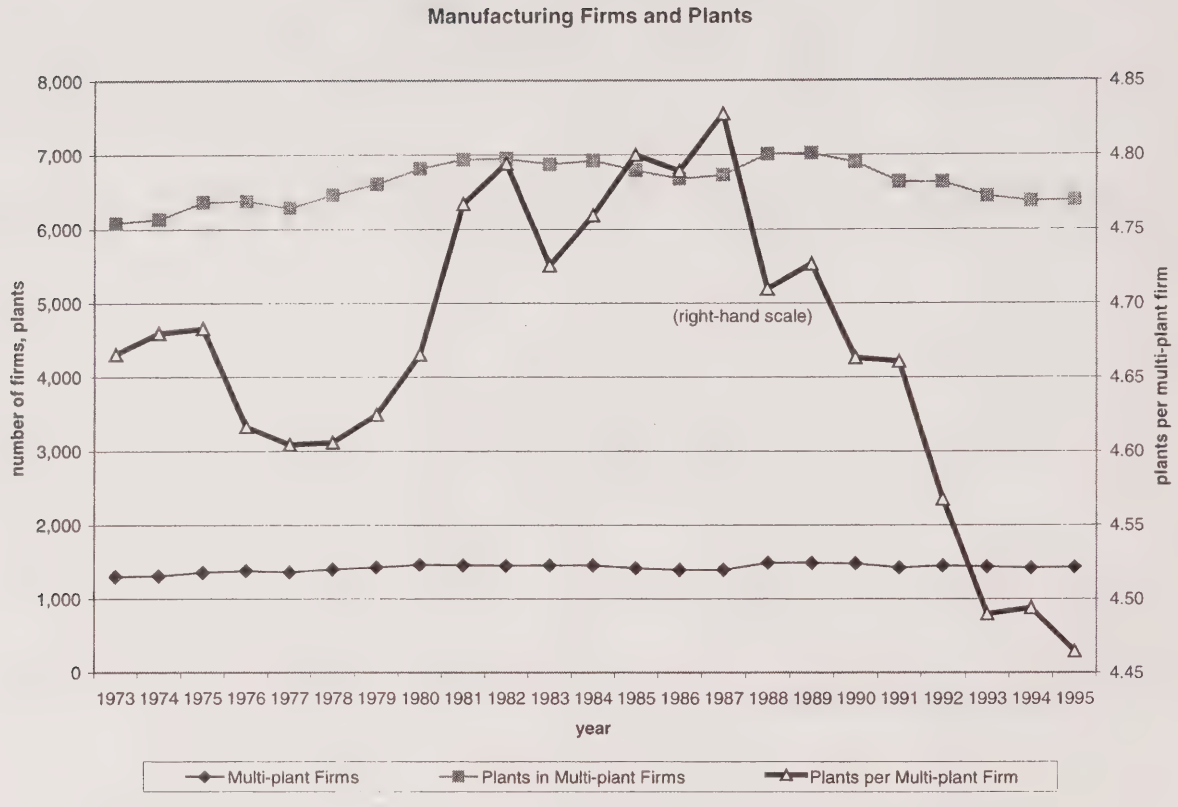
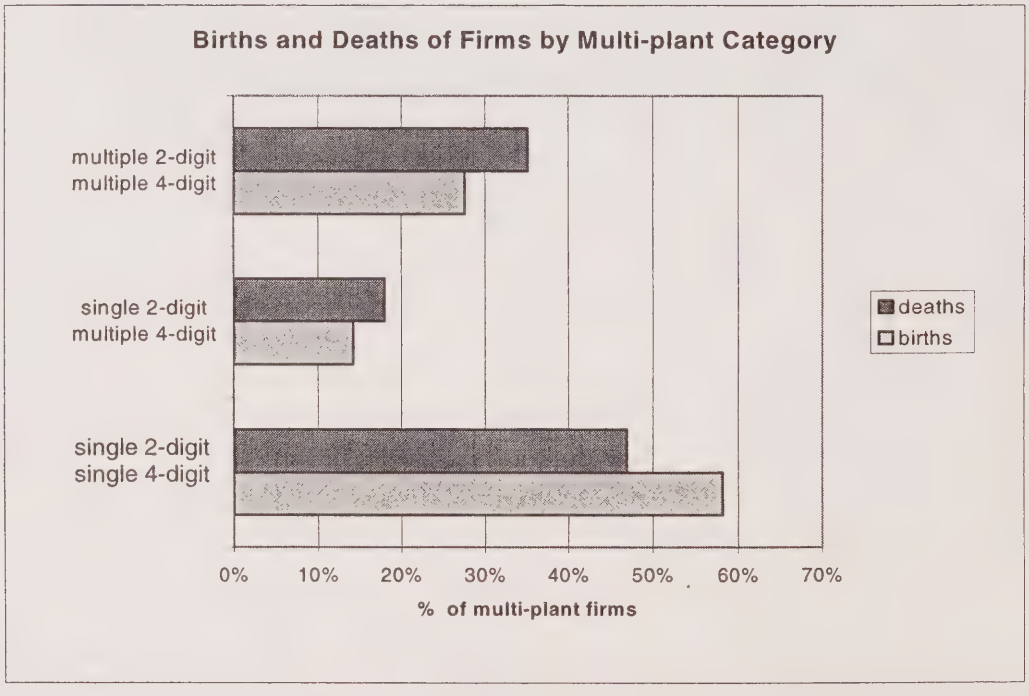


Figure 2



In summary, both in the continuing-firm and in the arrivals and exits populations, there is evidence of a movement away from multiple-industry, multiple-plant operations over the period.

6. *Entropy Measures of Diversification*

Measures of multi-plant operations only capture industry diversification imperfectly. Alternately, we could measure the number of industries in which a firm operates. But a simple count of the number of industries that a firm spans or the number of products produced ignores the relative importance of a firm's sales in different industries or by different commodities.

In order to overcome this problem, we use a diversification measure that takes into account both the number of industries (or commodities) which a firm operates in (or produces) and the distribution of its activity across industries (or commodities). The industry dimension considers 236 4-digit industries. The commodity dimension utilizes over 7,000 commodities.

An entropy measure of diversification is employed (see Jacquemin and Berry, 1979). We calculate two sets of diversity measures using the entropy measure. The first examines how firms diversify across industries. The second examines how plants diversify across product lines.

When we examine a firm's level of diversity across industries, we estimate how concentrated a firm's sales at the industry level are—whether the sales are concentrated entirely within one industry, or whether they are spread across several industries. The entropy index takes the general form:

$$(1) \qquad E(s) = \sum_{i=1}^{N} s_i \log(1/s_i)$$

where s_i equals the share of total firm activity in industry i. The entropy diversification index takes a value of zero when activity is concentrated entirely within a single industry. At the other extreme, if the firm's activity is spread evenly across K industries, the firm's entropy is maximised at $E(s) = \log(K)$.

We choose this index because it has the advantage that an overall measure of diversity (a firm's overall measure of cross-industry diversity) can be broken down additively into components (Jacquemin and Berry, 1979). For example, it can be divided into the amount due to diversity across 2-digit industries as opposed to the amount due to diversity across 4-digit industries within 2-digit industries. The former is generally treated as involving activities that are less related.

In this study, we also use a variant of the entropy index that transforms the measure by taking its antilog, which is referred to as the *numbers-equivalent* entropy. Its values are bounded between one and K: it equals one when 100% of a firm's activity is in one industry and it equals K when a firm's activity is spread equally across K industries. Other situations that fall in between are characterized by a numbers-equivalent that represents the number of industries over which a firm's activity would need to be equally spread in order to have the same value as the diversity

measure. For example, a firm that has a numbers-equivalent entropy of 7.3 is as diversified as one with activity evenly spread across seven industries.

The numbers-equivalent index can be standardized, when appropriate, to fall within a range of 0 to 1 by dividing it by the number of categories being used (K).[17] When we compare industry-level diversity over time, standardization is not required because we use the 1980 SIC classification over the entire time period.[18]

The entropy measure will be calculated both for the universe of firms[19] and for only those that are diversified. By dividing by the number of firms that are used to calculate each measure of entropy, we obtain a measure of average entropy per firm (for only the diversified group or for all firms in an industry). When we use the numbers-equivalent, this is equivalent to the number of industries covered by the average firm in the relevant population (just the diversified group or for all firms in the industry).

The industrial classification used for the manufacturing surveys is based on the Standard Industrial Classification (SIC) developed by Statistics Canada. In the 1980 edition of the SIC, there are four levels provided in its hierarchical structure. In this paper we make use of the intermediate 2-digit level, known as major groups, and the detailed 4-digit industry classes (236 classes).

7. Changes in Diversification Based on Entropy Measures

In the 1970s, the total numbers-equivalent entropy increased (Figure 3), albeit at a slower rate than the number of multi-plant firms. The 1980s saw a decrease in the aggregate numbers-equivalent to levels observed in the mid-70s and these decreases continued into the 1990s.

Aggregate entropy measures are a function both of the number of firms and the average diversity of each firm. The numbers-equivalent entropy measure divided by the number of multi-plant firms (the average entropy measure per firm) declines over the entire time period. Specialization movements are therefore more continuous for the numbers-equivalent entropy measure than for the multi-plant measure that only begins to decline late in the period. Moreover, the downward trend in the average entropy measure per firm begins at an earlier date.

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[17] Equivalently, the log entropy measure can be standardized by dividing by log(K).

[18] Although two SICs (the 1970 and 1980 SIC) were used by Statistics Canada during the period, we have reclassified all plants to the 1980 SIC for the purposes of this paper.

[19] Single-plant firms, by definition, have no cross-industry industrial diversification. The log entropy for each such firm is zero and its numbers-equivalent entropy is one. Hence, the aggregate log entropy for single-plant firms is zero and the aggregate numbers-equivalent entropy is simply equal to the number of such firms. The log entropy will be the same for the diversified and the total population though the average of the latter will be smaller than the average of the former.

It is possible to decompose the firm's total entropy (our measure of diversification) into two components—the part of the entropy due to diversification between or across broad industry groups (2-digit industries) and the part of the entropy due to diversification across more narrowly defined industries (4-digit industries) within the broad industry groups. This decomposition takes the form:

$$E(s) = E_b(s) + \sum_{g=1}^{G} S_g E_g(s)$$

where

$$E_b(s) = \sum_{g=1}^{G} S_g \log(1/S_g)$$

is the entropy between industry groups (i.e., 2-digit industries), and

$$E_g(s) = \sum_{i \in S_g} (y_i / Y_g) \log(Y_g / y_i)$$

is the entropy within a group (i.e., 4-digit industries within a 2-digit industry).[20]

Thus the total entropy depends both on the distribution of firm employment across separate 2-digit industry groups and, more narrowly, on the distribution of firm employment among different 4-digit industries within each 2-digit industry group.

The increase in specialization indicated by the aggregate entropy measure presented in Figure 3 could have occurred because firms had fewer operations across 2-digit industries or across 4-digit industries. Therefore, we examine trends in the degree to which firms were diversified across 2-digit industries, trends in the extent to which they were diversified across 4-digit industries, and the extent to which they were diversified across 4-digit industries within 2-digit industries using the decomposition described above.

Over the time period examined, diversity fell and specialization increased at all levels. The numbers-equivalent measure declined when diversification is measured at the 4-digit level, at the 2-digit level, and at the 4-digit level within 2-digit industries (Figure 4). At the 4-digit level, the decline is some 16%, but then the index of diversification at this level encompasses broad diversification at the 2-digit level and narrower diversification within 2-digit industries.

The proportion of the total entropy attributable to diversification across two-digit industries is the ratio of the between-group entropy to the total log entropy (Figure 5). Over the study period, the proportion of total log entropy attributed to diversification across industry groups varied between 54% and 58%. The proportion of the total entropy due to diversification across 2-digit industries increased during the 1970s but declined from 1980 onwards. Thus broad-based industry diversification tended to decline relative to narrow-based diversification since the 1980s.

[20] See Jacquemin and Berry (1979: 359-369).

Figure 3

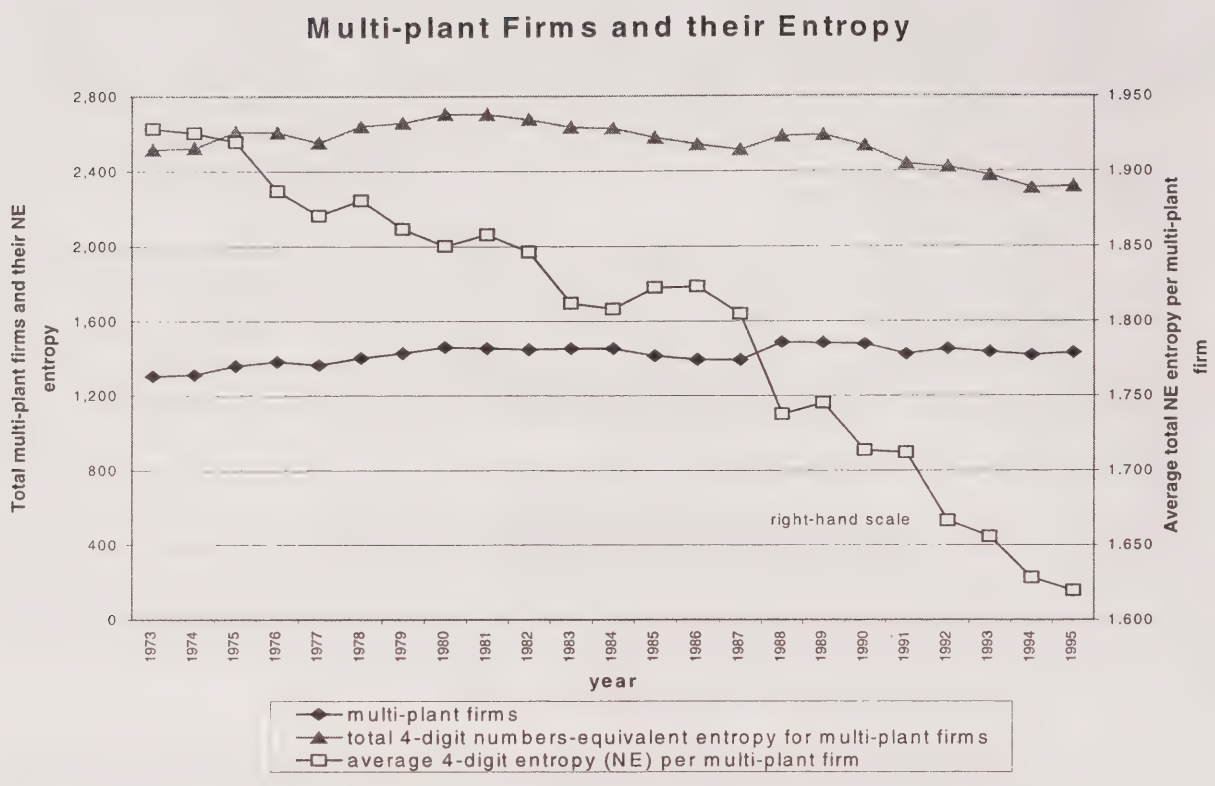
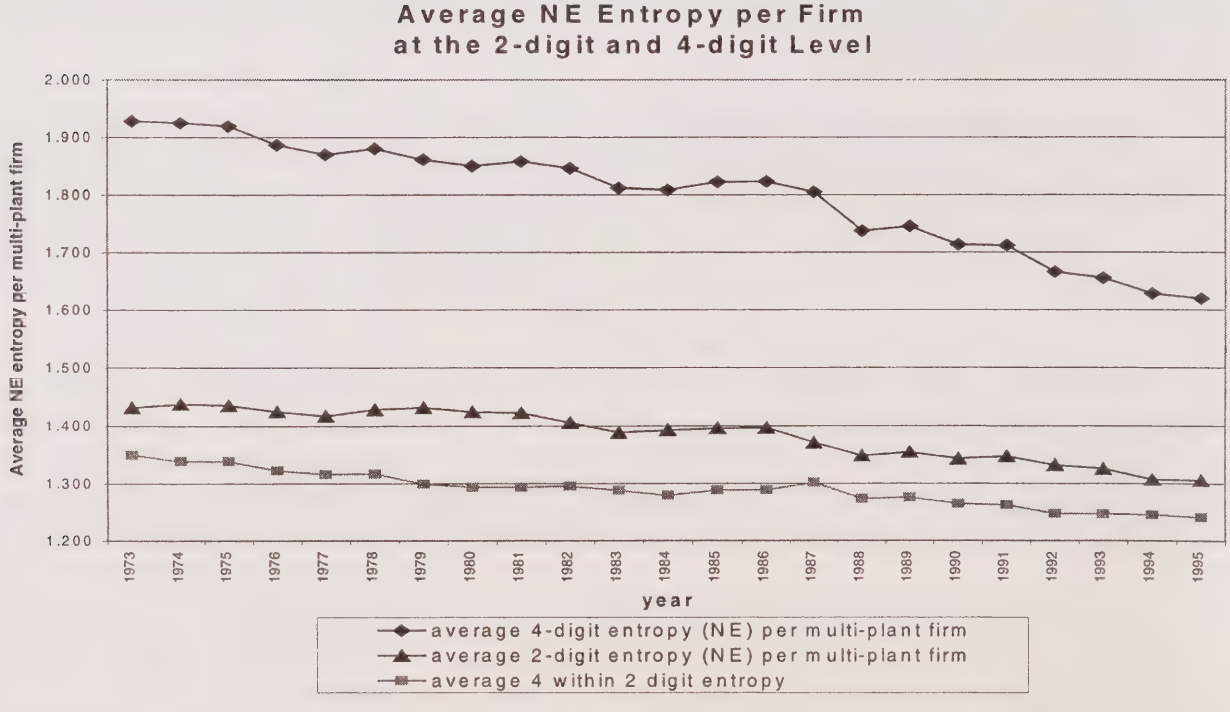


Figure 4



In summary, entropy measures based on the distribution of a firm's sales across industries show a different trajectory than the multiplant measure. The relative importance of multiplant firms stays unchanged over most of the period when measured in terms of their total numbers or their total sales. But the entropy measure that captures the extent to which the output of firms is equally distributed across industries declines more or less continuously. On this basis, we conclude that diversified Canadian manufacturing firms have retrenched and concentrated their production in fewer industries. The trend towards increased specialization has been more or less continuous since the early 1970s when diversity is measured in terms of the number of industries spanned (the numbers-equivalent entropy measure). The trend to specialization starts later (1988), when the number of plants per multiple-plant firm is used as a diversification measure. The difference in the timing of the decline shown by each of the two measures indicates that firms gradually increased the degree to which they specialized their sales in one industry throughout the period and that by the late 1980s, secondary plants had become sufficiently peripheral to core activities that they were increasingly discarded.

8. Commodity Diversification

We also utilize commodity measures to examine commodity diversification at both the firm and the plant level. Commodity measures at the level of the firm extend the previous analysis since measures of commodity diversification can occur without the firm actually crossing industry boundaries.[21] Commodity diversity measures at the firm level provide information that allows us to compare changes over time in the two different forms of diversification—industry versus commodity.

Commodity specialization at the firm level may increase because the economics of distribution or marketing reduce the number of product lines being produced—because the economies of joint marketing or distribution are no longer as important. Unrelated activities that may have been cobbled together in a frenzy of merger enthusiasm may be shed as the difficulties of coordinating unrelated activities lead firms to disentangle their unrelated activities and to concentrate on core activities.

These increases in firm-level specialization may or may not be accompanied by increasing specialization at the plant level. Changes in plant-level specialization arise from changes in the importance of scope economies associated with producing multiple commodities at the plant level or a change in the importance of production-line scale economies. These changes can originate in new technologies that increase the effect of scale economies or from changes in the competitive environment. Since these forces are not necessarily those that lead to the diversification of a firm's operations across separate industries, this section investigates whether the tendency to increase specialization at the industry level, which we have outlined in the previous sections, is also found at the plant level.

[21] A firm's plants may produce multiple commodities that all are classified to one industry.

Figure 5

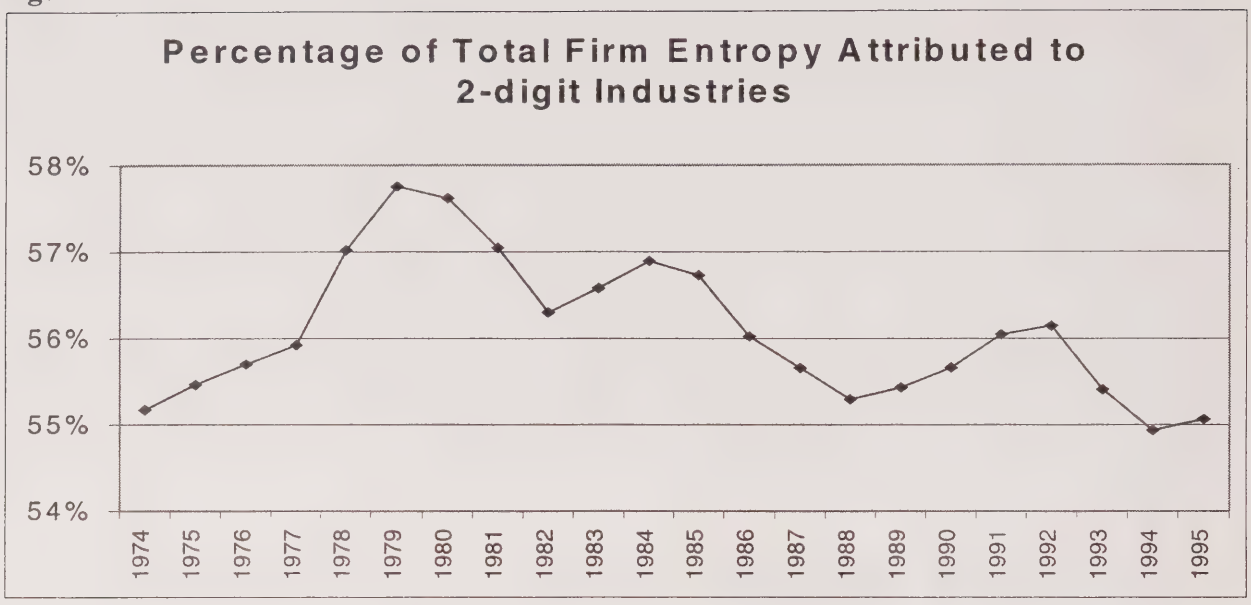
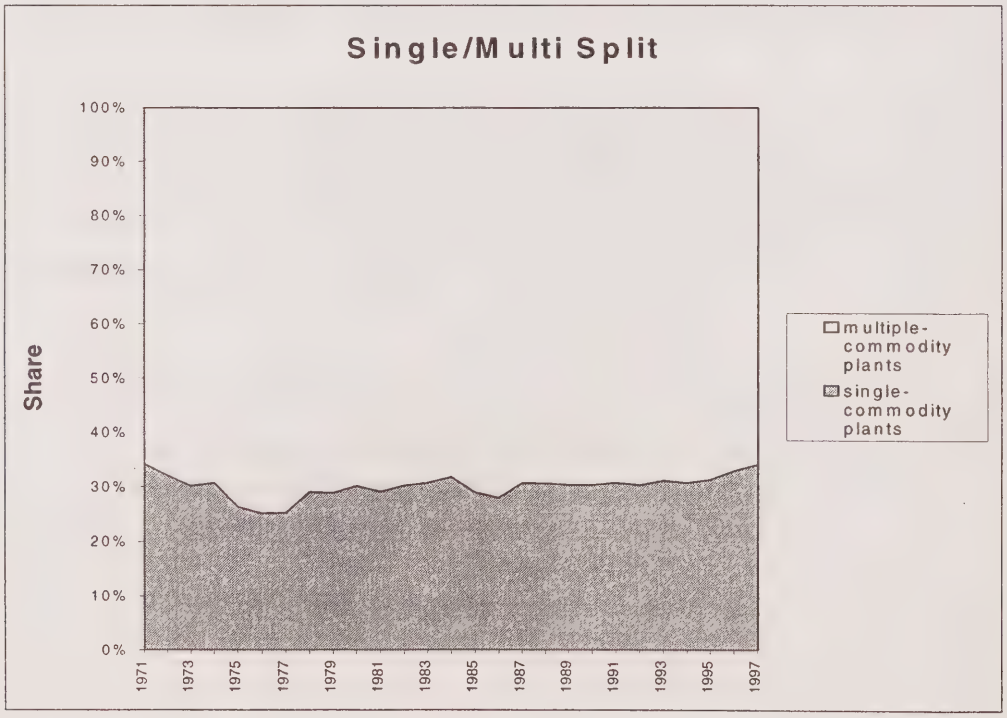


Figure 6



In order to investigate this issue, we make use of the commodity data from multi-commodity plants that are derived from the Annual Survey of Manufactures. It should be noted that not all plants are multi-commodity, but the split has been relatively constant over much of our study period (Figure 6).[22]

Not all plants are asked to enumerate the types of commodities that are produced. In what follows, we report the entropy measure for all plants that reported commodity data. When we turn to measure firm-level diversification in the commodity space, we divide firms into those that are diversified across industries and those that are multi-commodity so as to study whether different members of the diversified community act differently.

We measure the degree of commodity diversification in two ways. The first is the average number of commodities per multi-commodity plant. The second is the average numbers-equivalent derived from the entropy index calculated for multi-commodity plants.

We use the entropy measure to capture how diversified a plant or firm is across products. In this case, s_i in equation 1 is equal to the share of a plant or firm's sales accounted for by product i. It should be noted that the product codes come from a different coding system than is used for the SIC classification. The numbering system is not simply an extension of the four- or five-digit SIC code.

Contrary to the case for diversity measures constructed using industry sales data, diversity measures that we construct using commodity data have to consider whether standardization is required. This occurs because the commodity classification changes in 1988 from the Industrial Classification Code (ICC) to the Harmonized Classification System (HCC). In order to standardize our entropy measure, we can divide by log (N), where N is the number of products in the classification.[23] We did so and found that it changed our measure in only a minor way. It did not affect our conclusions about trends in specialization. Since the numbers-equivalent has a much more intuitive explanation, we report here only uncorrected numbers-equivalent commodity diversification measures.

We plot the two measures calculated as the average for all plants rather than just multi-commodity plants (Figure 7). The data for the all-plant universe jointly reflect what is happening in the multi-commodity plants and the percentage of plants that are multi-commodity.

[22]The number of multi-commodity plants surveyed has fluctuated over time. However, these fluctuations are not correlated with changes in the specialization measure reported here.

[23] N is 7,736 for the ICC and 8,492 for the HCC system.

Figure 7

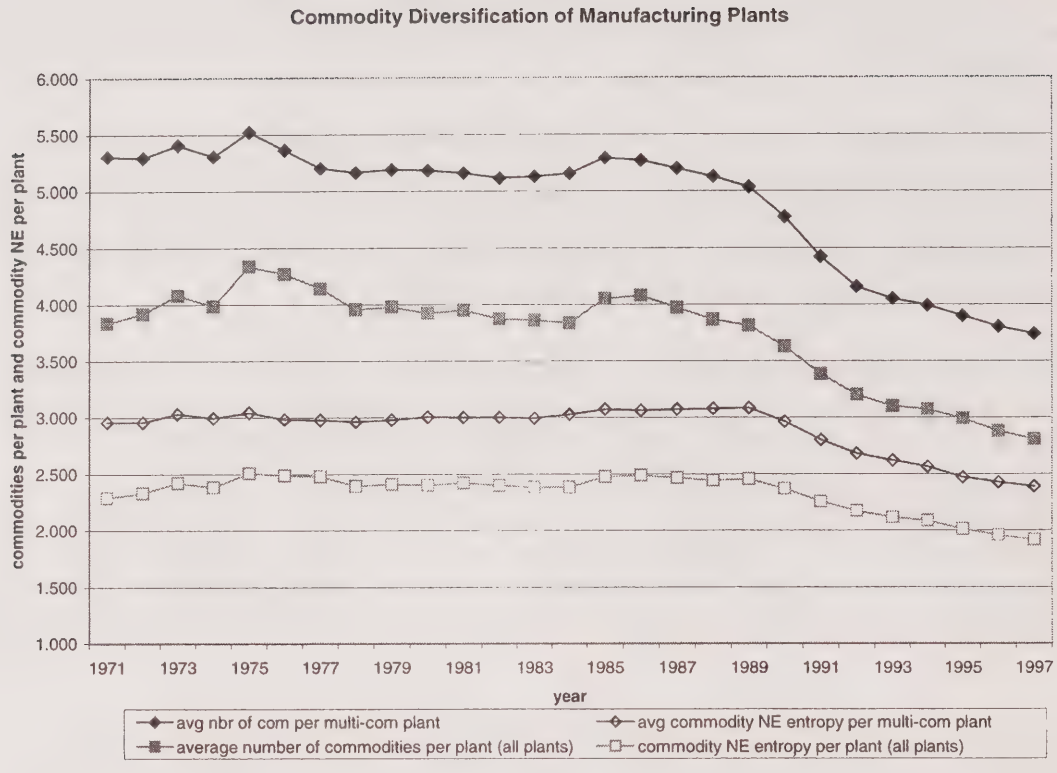
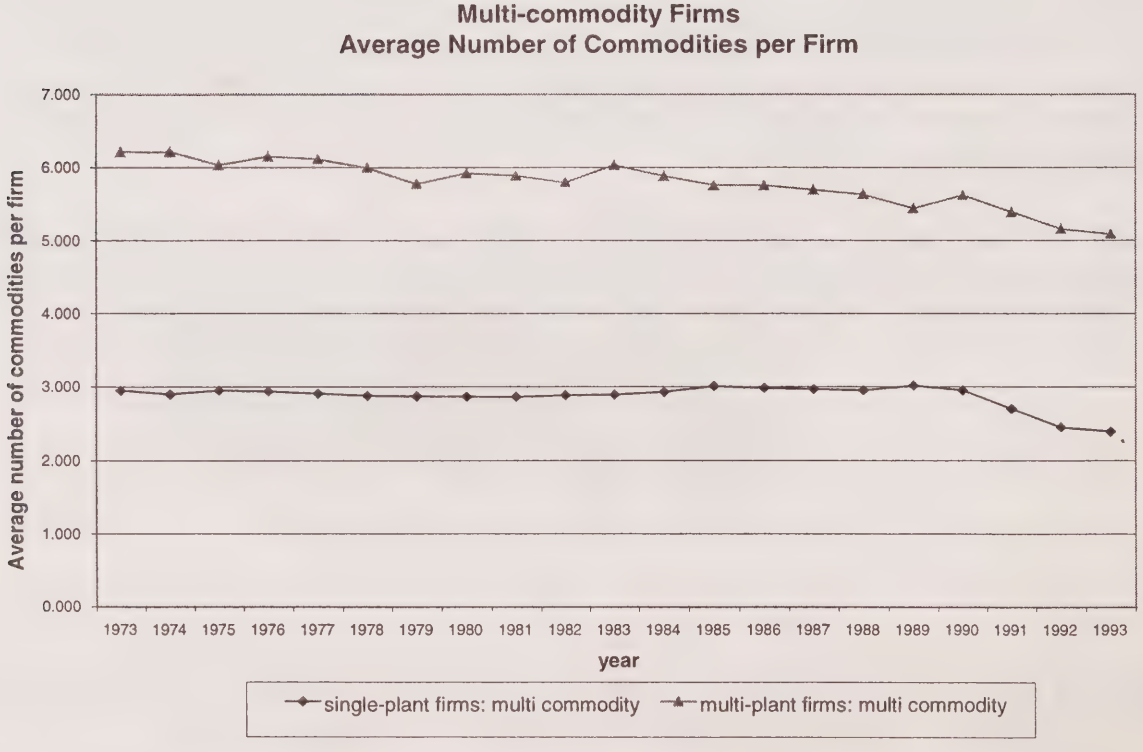


Figure 8



The two measures exhibit the same pattern for all plants and for just multi-commodity plants. The plant-level diversification numbers-equivalent is relatively constant from the early 1970s to 1987, but then it begins to decline.[24] By 1997, the number of commodities per multi-commodity plant falls by 28%. The numbers-equivalent per multi-commodity plant falls by about 20% over the same period. The discontinuity in plant specialization that starts late in the period stands in marked contrast to industry-level diversification measures presented in the previous section, which have declined more continuously over the entire period.[25]

Firm-level diversification measures based on commodity data will differ from plant-level commodity diversification measures because firm-level data are affected by both what is happening within plants and how plants across different industries are combined in one firm. To disentangle these two effects, we examine the nature of commodity diversification for different types of firms—for firms that have a single plant that produces more than one commodity and for firms that possess more than one plant producing multiple commodities.

The single-plant firm has a lower number of commodities produced and the downward trend in this variable is a little less marked than for the multi-plant firm (Figure 8). The number of commodities produced declines steadily over much of the period—but begins to decline more quickly in the late 1980s. The overall decline in the average number of commodities produced is about 29% for multi-commodity multi-plant firms and about 25% for multi-commodity single plant firms over the period 1986 to 1993.

9. Commodity versus Industry Diversification

Plants and firms have moved to concentrate on producing fewer commodities and they have focused on owning plants in fewer industries. However, the trajectory followed by industry and commodity diversification measures has not been the same. The increase in industry specialization is more continuous than the increase in plant specialization.

In order to emphasize the differences in the two measures, we compare the two for firms that possess multiple plants[26] and are multi-commodity (including both firms that are in a single industry and are in multiple industries) versus those that possess multiple plants, are multi-commodity, and are diversified across 4-digit industries. The latter exclude single industry plants. The first group makes up about 85% of all firms with commodity data while the latter make up about 40% of these firms (Figure 9).

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[24] As with the number of plants per firm, the commodity numbers-equivalent starts to decline two years before the FTA with the United States.

[25] Changes in administrative procedures are implemented within Statistics Canada in 1987 that have a one-time impact on the measured specialization index and that account for about half the decline in that year. This administrative change does not account for the continuous decline in the specialization ratio over the entire post-1987 time period.

[26] We focus just on multi-plant firms since these have greater potential for diversification. For this sample, we examine only those multi-plant firms for whom we have commodity data for all plants in the firm.

Figure 9

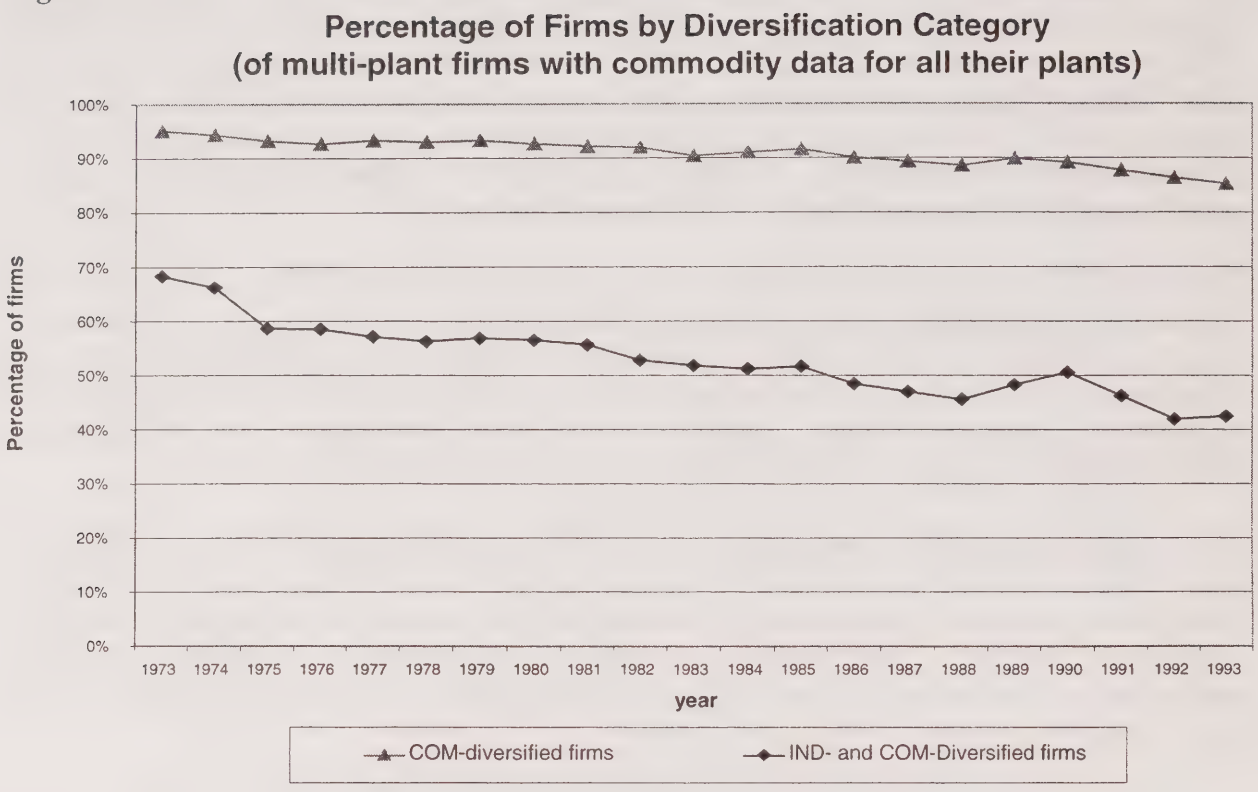
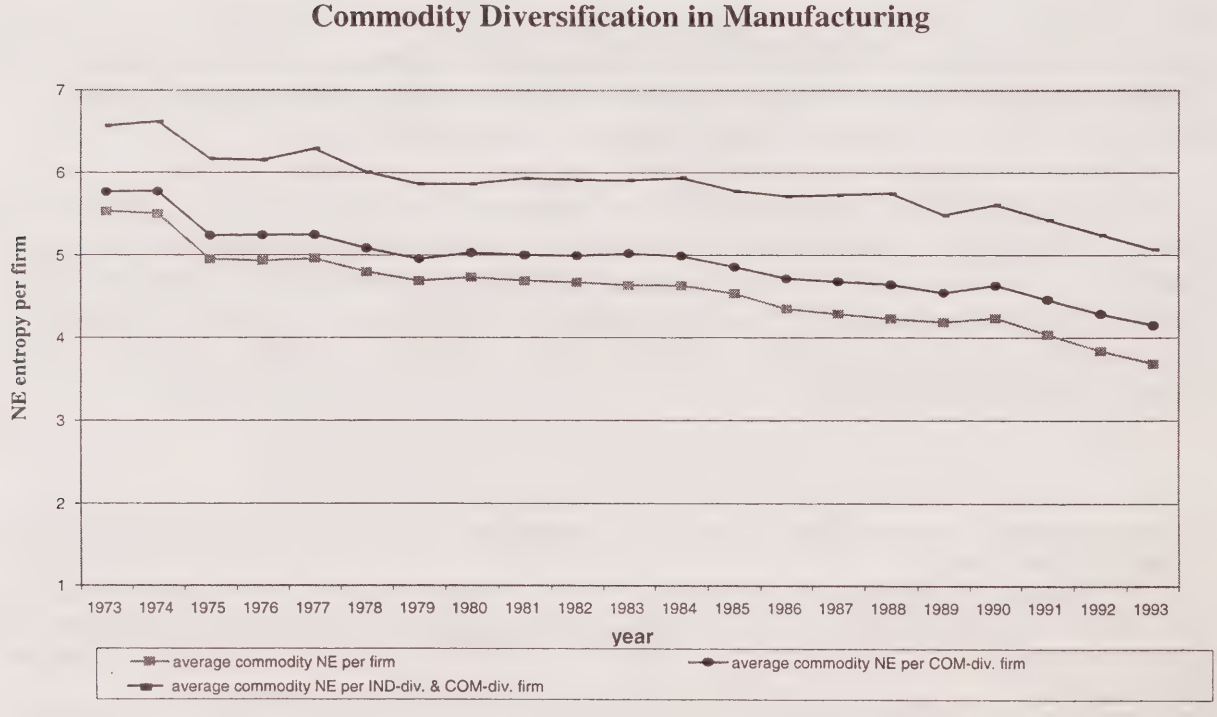


Figure 10



The average commodity numbers-equivalent is higher for multi-plant, multi-commodity firms that are also diversified across industries (Figure 10). It averages 5.9 compared to 4.9 for firms that are multi-plant and commodity diversified. And both are above the average commodity numbers- equivalent for all multi-plant firms, since the latter also contains single-product firms. Nevertheless all three commodity numbers-equivalent measures have been declining. Over the period 1973-1993, the commodity numbers-equivalent for firms that are both commodity and industry-diversified decreases by 23%; it declines by 18% for firms that are commodity diversified. (The latter includes multi-commodity firms that are not diversified across industries.) There has been a reduction in the number of commodities produced both by firms that had diversified across commodities and by those that had diversified across commodities and across industries.

Unrelated forms of diversification, it is sometimes argued, are among the least profitable.[27] If specialization primarily occurred as a result of a long-term withdrawal from the most unrelated forms of cross-industry diversification, we would expect a greater increase in specialization in firms that were diversified across 2-digit industries. We therefore investigate the extent to which the changes in commodity diversification varied across firms by type of industry diversification (Figure 11). For this purpose, we choose the four types previously examined—those firms possessing single plants (S_S2_S4), those firms possessing multiple plants but whose plants are in a single 2-digit and a single 4-digit industry (M-S2-S4), those firms occupying a single 2-digit industry but having plants in multiple 4-digit industries (M-S2-M4), and those firms crossing multiple 2-digit and 4-digit industries (M-M2-M4). For this purpose, we choose only those firms for whom all plants report their commodity information.

The average commodity numbers-equivalent is highest for the least related industrial diversification category (an average of 6.2 commodities) and lowest for the single industry category (an average of 2.2 commodities). Over the period from 1973-1993, it also declines most for the group of firms that are diversified across two digit industries—by about 27%. It declines less for firms that are only diversified across related 4-digit industries (by about 13%). It also declines less for multi-plant firms that are restricted to a single 4-digit industry (by 14%) and for the single-plant single industry-plants (by about 16%).

Changes in industrial diversification (the number of industries in which production takes place) can also be compared for the two groups of multi-plant firms—those that produce multiple commodities that are both single industry and multiple industry versus those producing multiple commodities spanning more than one industry (Figure 12). The average number of industries occupied by firms that are commodity diversified (including firms that are both single and multiple industry) is 1.7, while firms that are both commodity and industrially diversified occupy on average 2.1 industries. Both of the numbers-equivalent measures decline by about 19% over the entire period.

[27] See Rumelt (1974), Lecraw (1984) and Montgomery (1994).

Figure 11

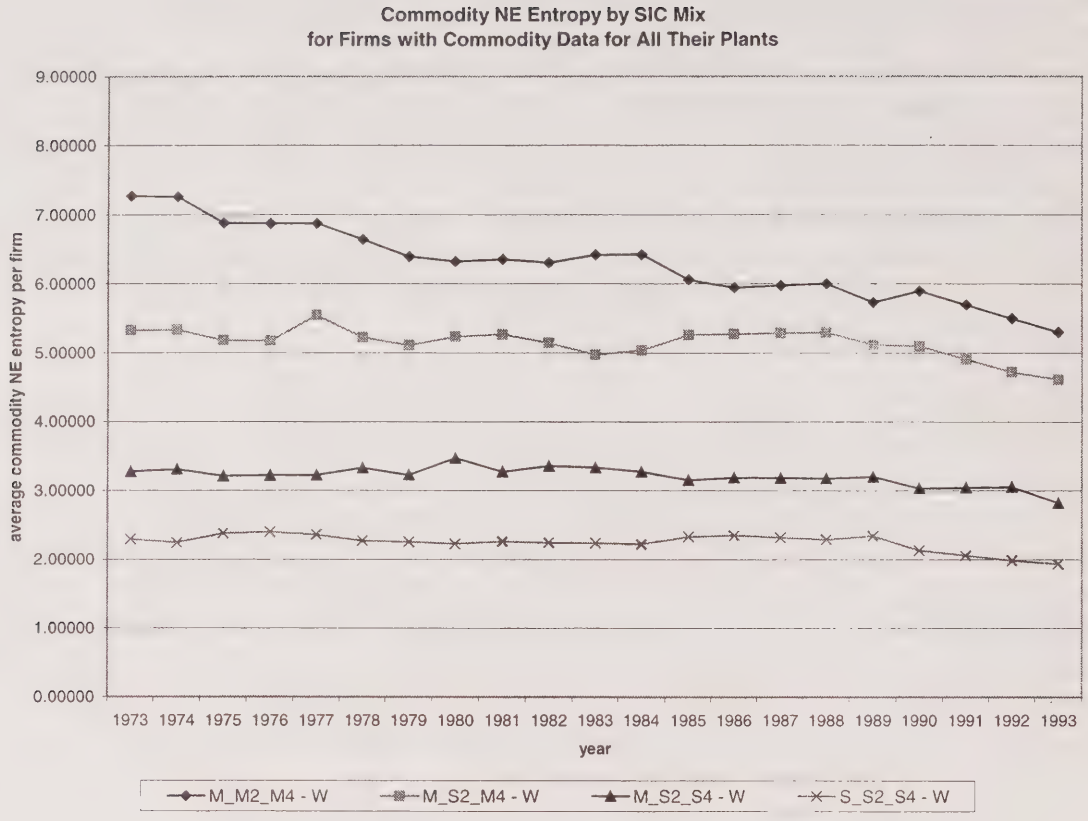
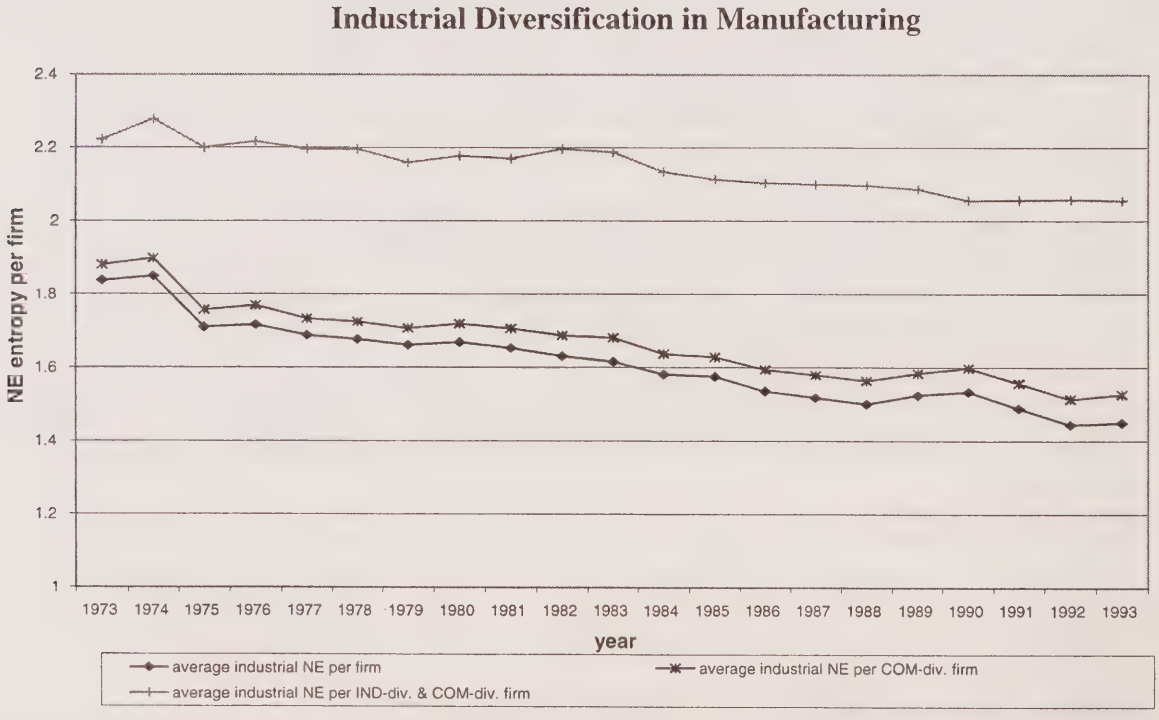


Figure 12



The relative movement of the commodity numbers-equivalent measure for firms to the industry numbers-equivalent measure for firms reveals which specialization trend has been the strongest (Figure 13). For firms that are multi-product (i.e., commodity diversified) that are both single and multiple industry, the ratio of the two is relatively flat over the period from 1973 to the mid-1980s; but it then declines some 10% by 1993. This suggests that the forces leading to specialization in this group over the earlier period at the product level were operating with about the same effect as the forces that decreased the numbers of industries in which the average firm in this group operated—but that late in the period, product line economies increased dramatically in importance.

By way of contrast, the commodity specialization index declines relative to the industry specialization index over the entire period for the group of firms who are both multi-industry and multi-commodity. For this, as for the previous group, there is also a movement to a specialization of commodities—but the increase in commodity specialization occurs at a faster pace than industry specialization, thereby confirming the importance of the former in the case of the industry-diversified population. Firms that were more diversified, in the sense of being diversified across industries as well as across commodities, increase their specialization at the plant level relatively more than they increase their specialization at the industry level over most of the period. Despite this difference, the end of the period saw a dramatic increase in commodity specialization at the plant level in the group of firms that were industrially diversified.

In summary, commodity data show quite a different path over the last three decades compared to the trajectory followed by the industry diversification measures. At the industry level, there has been a more or less steady decline in diversification. Firms reduced the degree to which they were diversified across industries—particularly across industries that were less related. On the other hand, diversification across commodities remained relatively constant over most of the period; but at the end of the period, plants began to increase their degree of plant specialization.

10. Diversification at the Two-digit SIC Level

In the previous sections, we have examined changes over time in the extent to which firms diversified across industries and combined products at the plant level. The evidence suggests that specialization has increased in both dimensions—though at different rates. Diversification across industries has been decreasing steadily over the last twenty years—with firms moving to concentrate activities within more narrowly defined sectors. On the other hand, commodity diversification was relatively constant over most of the period with declines starting in earnest in the late 1980s.

Figure 13

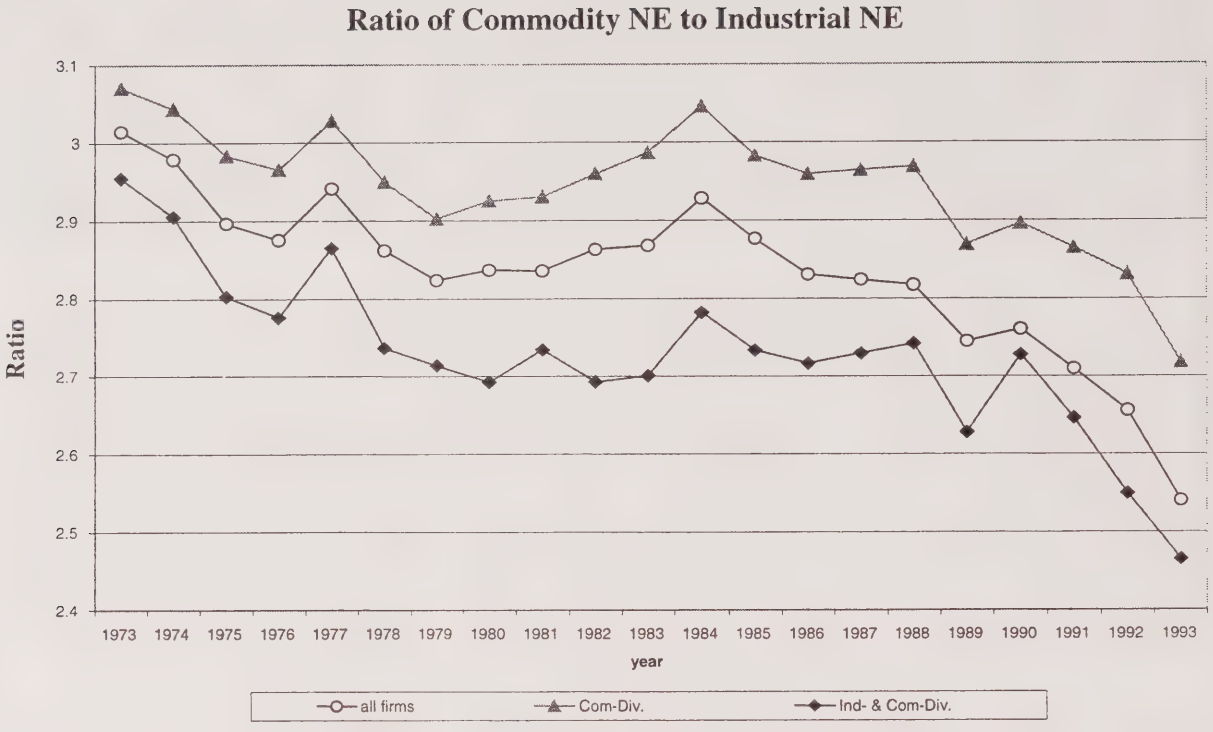
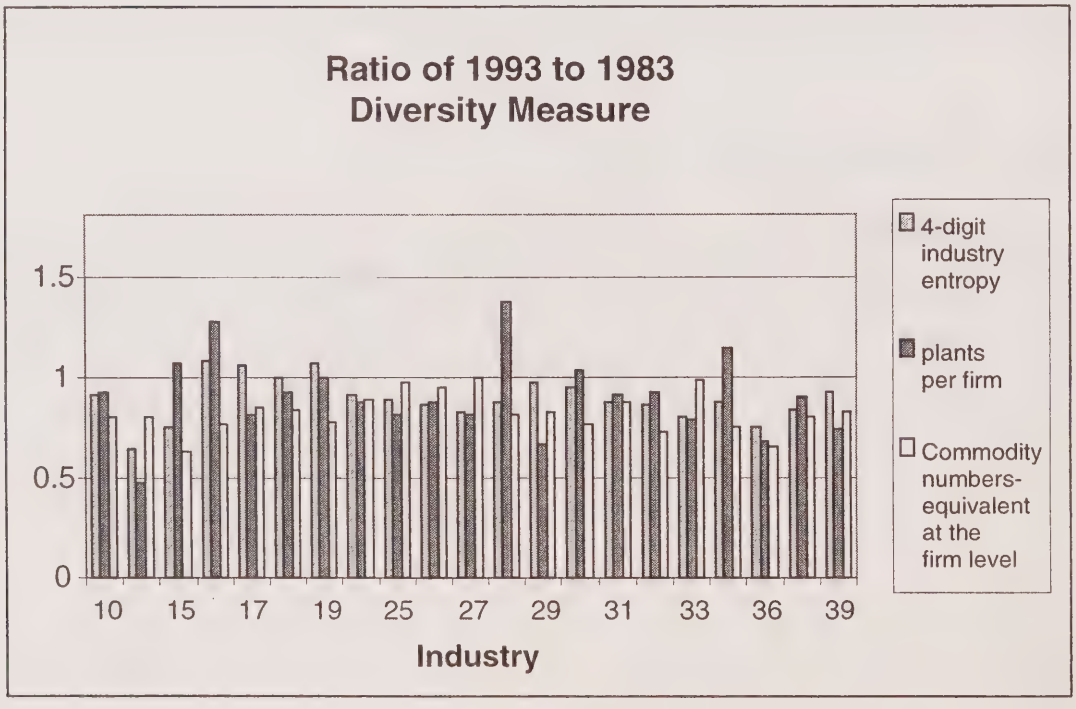


Figure 14



These differences in the paths followed by each index may arise from completely different forces. One way to investigate this is to examine the correlations between the various indices at the industry level. High positive correlations suggest similar forces are work at the industry level. Negative correlations suggest that different forces are at work.

Table 2 contains four different measures of diversification for 2-digit industries in the manufacturing sector for 1993. The measures are the industry numbers-equivalent entropy for the number of industries into which a firm is diversified, the number of plants per firm, and the commodity numbers-equivalent for multi-commodity firms and the commodity numbers-equivalent for multi-commodity plants. [28]

Table 2. Diversification Measures for 2-digit Industries (1993)

Industry	SIC	Industry 4-digit numbers-equivalent	Plants per firm	Diversified firm commodity numbers-equivalent	Diversified plant commodity numbers-equivalent
Food	10	1.6	5.1	2.7	3.3
Beverage	11	1.3	4.3	3.6	3.4
Rubber	15	1.5	3.8	2.1	2.7
Plastics	16	1.5	3.4	2.4	2.3
Leather	17	1.4	2.6	2.5	2.4
Primary textiles	18	1.9	4.4	2.1	2.1
Textile products	19	1.5	2.8	2.3	2.3
Clothing	24	1.3	2.4	3.1	3.1
Wood	25	1.5	3.1	2.4	2.4
Furniture and fixtures	26	1.6	2.9	2.3	2.3
Paper	27	2.1	6.6	2.8	2.1
Printing	28	1.4	6.5	2.7	3.0
Primary metals	29	2.0	5.7	2.5	2.5
Fabricated metals	30	1.8	3.6	2.2	2.2
Machinery	31	1.7	2.8	2.5	2.4
Transportation	32	1.9	4.4	2.3	2.1
Electrical	33	1.7	3.8	2.3	2.3
Non-metallic	35	1.7	7.8	2.4	2.4
Refined petroleum	36	1.9	5.1	2.5	3.1
Chemical	37	1.8	4.5	3.6	3.3
Other	39	1.4	3.0	2.2	2.1

Industries possessing firms that are diversified into other industries are also industries where firms possess more plants per firm. The correlation between the industry numbers-equivalent and the number of plants per multi-plant firm is 0.48.

Industries that have firms that are highly diversified across commodities are also those with plants that are diversified across commodities. The correlation between the two commodity numbers-equivalent measures at the industry level is 0.75.

[28] The firm numbers-equivalent is calculated only for multi-commodity firms where commodity data on all plants in a firm are available.

In contrast, the cross-industry measures of diversification and the measures of commodity diversification are negatively related. The correlation between the numbers-equivalent for cross-industry diversity and commodity level diversity at the firm level is -0.18 and for diversified plants, is -0.32. Industries where firms are diversified into other industries are not those where the firms or plants have diversified into more commodities.

Over time, almost all of the industries have experienced the changes that have been described previously. Figure 14 plots the ratio of the diversity measures in 1993 divided by the value of the measures in 1983. In almost all cases, the measure is less than one, indicating a reduction in the number of industries across which production occurs or the number of commodities produced. The changes in diversity are widespread. Changes in the aggregate statistics do not come just from a small number of sectors.

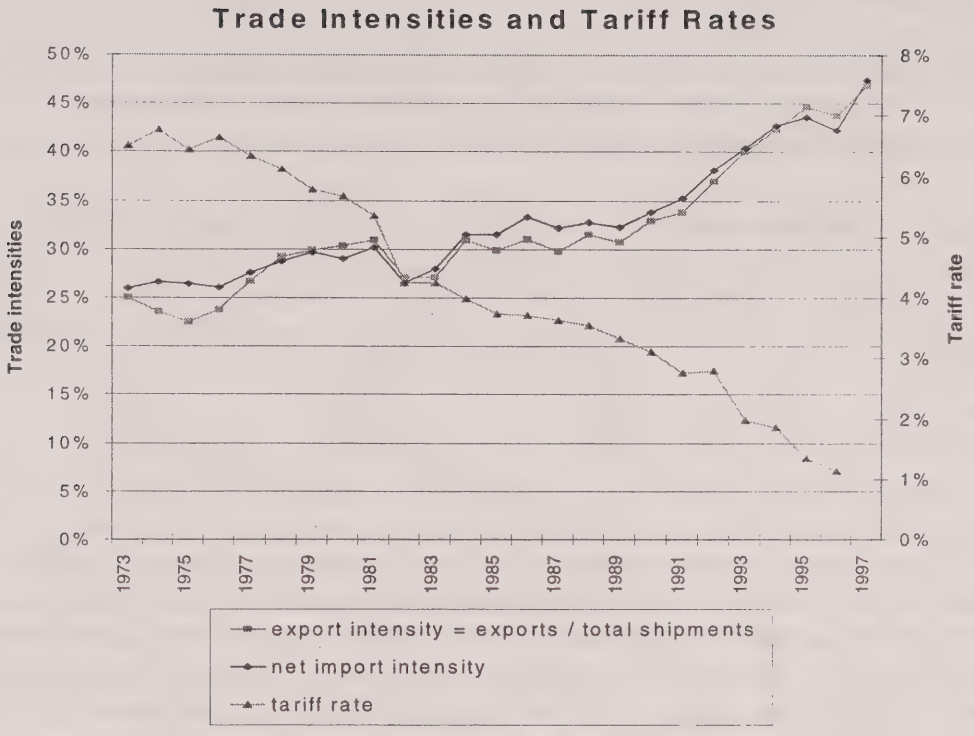
Equally important, the changes that have occurred recently have affected industries differentially. To examine changes in diversification between the 1980s and 1990s, we divide the value of the 1993 measure of diversification by its 1983 counterpart. The correlation of this ratio for the industry numbers-equivalent and the numbers of plants per firm is 0.64. In industries where firms reduced the average number of plants that they operated, firms were no longer operating in as many other industries. On the other hand, the correlation between this ratio of the industry numbers-equivalent to the plant commodity numbers-equivalent is -0.18.[29] Where firms were focusing more narrowly on their main industry, they were not reducing the commodities they were producing per plant. Two quite different types of consolidation were taking place.

11. Changes in Specialization and Trade Liberalization

Changes in specialization that have been outlined in the previous sections have been taking place at the same time as major changes in trade intensity associated with trade liberalization have occurred. Tariffs steadily declined over the three decades studied here, first with the Kennedy round in the 1970s and then with the Tokyo round in the 1980s. The average nominal tariff (customs duties paid divided by imports) was 6.5% in 1973 and had declined to 4.0 % by 1984 and then to 3.3% by 1989. With these declines came a gradual increase in trade intensity. The ratio of exports to production in the manufacturing sector increased steadily from 25% in 1973 to 31% in 1989. Over the same period, imports as a percent of domestic disappearance (production minus exports plus imports) increased from 26% to 32% (see Figure 15).

[29] It is true, however, that where firms were reducing industry diversification, they are reducing their commodity diversification. The correlation between the ratio of the industry numbers-equivalent and the firm commodity numbers-equivalent was 0.21.

Figure 15



Starting in 1989, two major changes occurred in the trading environment that faced Canadian manufacturers. First, the Free Trade Agreement (FTA) between Canada and the United States guaranteed a new type of open-border arrangement between these two countries. Then the North American Free Trade Agreement (NAFTA) in 1994 brought together Canada, Mexico and the United States. These agreements continued a process that extended back to the post-world World War II commitments to reduce tariffs and expand international trade. The average tariff collected continued its downward trend during the 1990s—from 3.3% in 1989 to 1.1% in 1996. But the FTA and NAFTA changes marked a turning point in that they set a time table for the elimination of tariffs and a framework for the resolution of trade disputes that was intended to give companies greater certainty for foreign direct investment.

The result was an increase during the 1990s in both the export intensity and the import intensity of the Canadian manufacturing sector (Figure 15). Export intensity and import intensity increased from around 31% in 1990 to 47% in 1997. The Free Trade Agreement between Canada and the United States essentially allowed a process that had begun in the 1970s and 1980s to continue into the 1990s.

Previous empirical work suggests that trade liberalization in the early 1990s might have been expected to have increased plant specialization. Earlier studies by Baldwin and Gorecki (1983a, 1986) made use of data for the 1970s to study whether the reduction in tariffs that occurred under the Kennedy round was associated with an increase in plant specialization. During this period of gradual tariff reductions, plant specialization increased slightly, as did the length of the

production run. Increases in the latter, though not the former, were greater in those industries where tariffs declined the most.

Our data on plant specialization that show a distinct break just before the FTA, and a continuous decline since then, provide strong support for the hypothesis that the final step towards trade liberalization was accompanied by a further increase in specialization.

Table 3. Relationship Between Trade Intensity and Changes in Diversification

Period t over period t+1	Export intensity 1973	Export intensity 1984	Import intensity 1973	Import intensity 1984
Plant commodity n.e.	-0.127	-0.078	-0.230	-0.390
Firm commodity n.e.	-0.053	0.155	-0.261	-0.248
Industry 4-digit n.e.	-0.107	0.012	-0.181	0.302
Plants per multi-plant firm	0.129	-0.062	0.098	0.140

Since we are interested in the extent to which the changes that we have described in the previous section were related to the trade environment, we first examine the changes that occurred at the 2-digit industry level in the four diversification measures reported in Table 2 and compare them both to the beginning-of-period trade intensity (Table 3) and changes in the trade intensity (Table 4).[30] Trade intensity is measured both using exports divided by domestic production and as imports over domestic disappearance.[31] We calculate correlations between the changes in diversification and the trade intensity variables across 21 two-digit industries over the 1984-93 period and 19 2-digit industries over the period 1973-84. The high level of aggregation employed makes this a weak test.

Table 4. Relationship Between Trade Intensity and Changes in Diversification

Period t over period t+1	Change in export intensity (1973-84)	Change in export intensity (1984-93)	Change in import intensity (1973-84)	Change in import intensity (1984-93)
Plant commodity n.e.	-0.385	-0.101	-0.264	-0.198
Firm commodity n.e.	-0.113	-0.093	-0.208	-0.026
Industry 4-digit n.e.	-0.405	0.051	-0.090	0.388
Plants per multi-plant firm	-0.378	-0.286	0.021	-0.083

In both periods, the commodity numbers-equivalent measures of diversity (both for plants and firms) fall in those industries where both export and import intensity is relatively higher though, at this level of aggregation, none of the correlations is significantly different from zero (Table 3). There is no clear pattern of a relationship between the initial level of trade intensity and either changes in the industry measure or changes in the number of plants.

[30] Changes are measured in terms of percentage point differences.
[31] We define imports to be net of re-exports.

In both periods, industries with larger increases in both export and import intensities are those where commodity specialization at the plant level has increased, since the correlations between the ratio of the value of the change in the diversity index to changes in trade intensity are negative (Table 4). The correlations are slightly higher in the 1970s than the 1980s.

Industry specialization has increased most where export intensity has increased; but it has decreased where import intensity has increased. This suggests that plant and firm intensity respond differentially to trade. Whereas it is difficult to disentangle whether it is exports or imports that leads to greater plant level commodity specialization, it is the increasing export intensity of an industry that appears to lead to industry specialization. In industries that are increasing import intensity, firms actually become less not more specialized—especially in the most recent period.

12. A Multivariate Analysis of Changes in Plant Specialization

While the relationship that we have described in the previous section between relatively aggregate measures of the changes in commodity specialization and trade intensity suggest that the two were linked, corroborative evidence is required that links changes in trade patterns at the plant level to changes in specialization that were occurring. To do so, we examine changes in plant specialization and changes in export intensity using micro data on manufacturing plants.

We construct a linked panel data set on plants in the manufacturing sector for the years 1974, 1984 and 1993. Data on manufacturing output (shipments) and employment are available throughout the period from the Census of Manufactures for each plant in the manufacturing sector. To these data are added characteristics of the plant's owning enterprise—whether the firm is foreign-owned and is diversified across manufacturing industries. In addition, the percentage of sales that are exported is available for the years 1974, 1984 and 1993. While the latter are only available for plants that answer the long-form questionnaire, this is the same group for whom we have commodity data and for whom we calculate a commodity entropy measure—our product specialization ratio.[32]

We use these data first to examine the relationship between plant specialization and export activity at the plant level for each year in our panel data set. In particular, we ask whether plants that export a larger percentage of their sales are also more likely to be specialized, holding plant size and nationality of ownership constant.[33] Plant size is included since previous work has found that larger plants are more diversified than smaller plants (Baldwin and Gorecki, 1983a; 1986). In addition, foreign ownership is included in order to remove its effect on a plant's likelihood to export.

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[32] Long-form plants accounted for 66% of the population in the years 1974 but only 49% in 1993. However, they accounted for 95% and 87% of shipments in these two years.

[33] We use export intensity of the plant because we only have export intensity at the micro level. Future work will add industry import trade intensity and other industry characteristics.

We estimate cross sections for the years 1974, 1984 and 1993 by regressing the plant-level commodity numbers-equivalent on the measure of export intensity of the plant (EXP), its nationality (FOR), and plant size (SIZE). Size is measured by employment. EXP is measured by the ratio of exports to total shipments. FOR is a binary variable taking on a value of one if the plant is foreign-controlled and zero if domestic. We also include interaction variables between foreign ownership and plant size as well as foreign ownership and export intensity. The years that are used are chosen because they cover two decades when trade intensity was increasing and specialization was occurring, though increases in the latter were more marked in the second decade than the first. Two results are reported in Table 5—one without foreign ownership and one with foreign ownership.

The estimated equation is:

$$(1)\ PDCT_t = \alpha_1 + \alpha_2 * EXP_t + \alpha_3 * SIZE_t + \alpha^*_4 FOR_t + \alpha_4 * FOR_t * EXP_t + \alpha_5 * FOR_t * SIZE_t$$

When the effect of foreign ownership is excluded, export intensity is negatively related to the number of products produced. In the cross-section, plants with higher export intensities have fewer products. In the cross-section, larger plants produce a larger number of products.

Over time, the coefficient attached to size declines. Larger plants have thus become more specialized. On the other hand, the effect of export intensity has varied over time, but it is higher by 1993 than it was in the early 1970s—suggesting that the effect of competitive pressures leading to specialization that are associated with trade increased over the period as did trade intensity (Figure 15).

The effect of foreign ownership has changed over time. In the early 1970s, foreign-owned plants have a larger intercept but a lower slope on export intensity. Above an export intensity of around 25%, foreign-owned plants tended to be more specialized than their domestic counterparts. But the specialization of this group changes in a complex way over time—the foreign intercept declines, the interaction term with size decreases, and the interaction term on trade intensity becomes positive by 1993.

Table 5. Characteristics Associated with Commodity Numbers-equivalent

Variable	1974		1984		1993	
INTERCEPT	.437*	.428*	.443*	.446*	.442*	.455*
SIZE	.082*	.079*	.055*	.061*	.041*	.062*
EXPINTENSITY	-.109*	-.070*	-.156*	-.156*	-.135*	-.159*
FOREIGN		.020*		-.008		-.038*
FOREIGN *SIZE		.0051		-.0085		-.033***
FOREIGN *EXPINTENSITY		-.0795*		.00731		.062**
F	77.54	33.04	67.38	27.36	43.54	21.801
PROB >F	.0001	.0001	.0001	.0001	.0001	.0001
N	4422	4422	4470	4470	3739	3739

* significant at 1% level ** significant at 5% level ***significant at 10% level.

We also examine the changes that occur over time in plant specialization by using a linked file for plants that continue in existence over the period 1973-84 and 1984-93. Longitudinal panel data allow us to directly examine changes in specialization that occur simultaneously with a change in export intensity and to deal with fixed effects that may make our cross-sectional estimates difficult to interpret. In our case, the effect of changes in export intensity may be inaccurately measured from the cross-sectional regression if export intensity is itself correlated with unobserved characteristics of a plant that determine its degree of specialization. There are a number of structural characteristics that are likely correlated with export intensity. When these unobserved effects are relatively constant over time, taking first differences of changes of the variables over time allows us to develop more accurate estimates of the actual effects of changes in export intensity. We therefore ask whether the numbers-equivalent changes over time where plants get larger and where export intensity changes. We expect that the former will lead to more commodities being produced and the latter will lead to fewer commodities being produced. We also ask whether this process differs for domestic- and foreign-owned plants.

The model used for the longitudinal regression analysis is:

$$(2)\ \Delta PDCT_{t-(t-1)} = \alpha_1 * FOR_{t-1} + \alpha_2 * \Delta EXP_{t-(t-1)} + \alpha_3 * \Delta SIZE_{t-(t-1)} + \alpha_4 * FOR_{t-1} * \Delta EXP_{t-(t-1)} + \alpha_5 * FOR_{t-1} ** \Delta SIZE_{t-(t-1)}.$$ [34]

The coefficients of the first differences are reported in Table 6, again excluding the effects of foreign ownership (columns 1 and 3), and including the effects of foreign ownership (columns 2 and 4). When foreign ownership is excluded, changes in size are positively related to changes in the numbers-equivalent, while changes in export intensity are negatively related to changes in the numbers-equivalent. The sign of both coefficients confirms our hypotheses based on the cross-section results.

Turning to the effect of foreign ownership, we see that when we abstract from size and export intensity changes, foreign owned plants have increased their specialization significantly (FOR is negative). It is also the case that the impact of increases in export intensity are significantly greater than for domestic plants (the interaction of FOR and ΔEXPINT is significantly negative). On average then, foreign-owned plants have become more specialized and the specializing effect of increasing export trade has been increased.

These results are compatible with the hypothesis that foreign subsidiaries have adapted to "excess" diversification more easily than domestic enterprises because they generally have more options for adjusting to small domestic markets that are not open (or open only with contractual hazards) to their domestic competitors. For example, items in a product line or inputs subject to scale economies can be sourced abroad from a corporate sibling rather than produced at high cost domestically. Our results show that foreign-owned firms have been adapting to trade liberalization over time by reducing product diversification at the plant level.

[34] We omit the intercept in this model because it is insignificant, thereby suggesting that the fixed effects model is appropriate.

Table 6. Characteristics Associated with Changes in Commodity Numbers-equivalent

Variable	1974-84		1984-93	
	(1)	(2)	(3)	(4)
Δ SIZE	1.20*	1.1*	.66*	0.69*
ΔEXPINTENSITY	-.442**	.011	-.397***	.018
FOREIGN		-.104**		-.206*
FOREIGN *Δ SIZE		.00020		-.00016
FOREIGN*ΔEXPINTENSITY		-.823***		-.780***
F	30.64	14.21	9.36	5.33
PROB >F	.0001	.0001	.0001	.0001
N	2621	2621	2243	2243

* significant at 1% level ** significant at 5% level ***significant at 10% level.

13. Conclusion

Recently, it has become conventional to observe that many firms in the 1990s are in the process of discarding peripheral activities in order to concentrate on their core business. To some observers, this is just the reaction of markets to previous unreasonable bursts of exuberance that led to mergers that were not economically sensible. While this may explain recent trends to deconsolidation in United States markets, it may be less relevant to the Canadian economy.

This paper has shown that firm specialization that is occurring in Canada in the 1990s is simply a continuation of a long-run trend. For the last twenty-five years, firms in the Canadian manufacturing sector have gradually been reducing their diversification.

This has taken place on two levels. On the one hand, firms have been reducing the span of industries in which they operate. In particular, diversification across unrelated broad industry groups has been reduced somewhat more than diversification across industries within these broader classifications. The trend to specialization in fewer industries has been more or less continuous and probably reflects the gradual increase in the size of the market served by Canadian firms. More recently, it has also been accompanied by a reduction in the number of plants operated per multi-plant firms. The latter experiences a sharp break in the late 1980s and a continuous downward trend into the 1990s.

There has also been an increase in commodity specialization at the plant level. However, in contrast to the experience with industry level diversification, this phenomenon has emerged only late in the period around the period when the Free Trade Agreement was implemented between Canada and the United States. These changes at the plant level have been closely associated with changing trade patterns. Plants that increased their export intensity tended to increase their product-level specialization the most. Moreover, foreign-owned plants increased their specialization more than did domestic plants. Foreign-owned plants (especially those with low export intensity) were more diversified before the FTA and responded more to trade liberalization than did foreign plants.

While changes in plant level specialization then are partially explained by the increasing competitive pressures that have been placed on Canadian manufacturing firms by trade liberalization, the same pressures have been at work at the firm level. Tariff and non-tariff barriers protected most Canadian markets in the early 1970s. Their gradual reduction over this period would have placed pressure on firms to spin-off their most unproductive operations. Whether trade liberalization was as important for firm specialization at the industry level as for commodity specialization must await further study.

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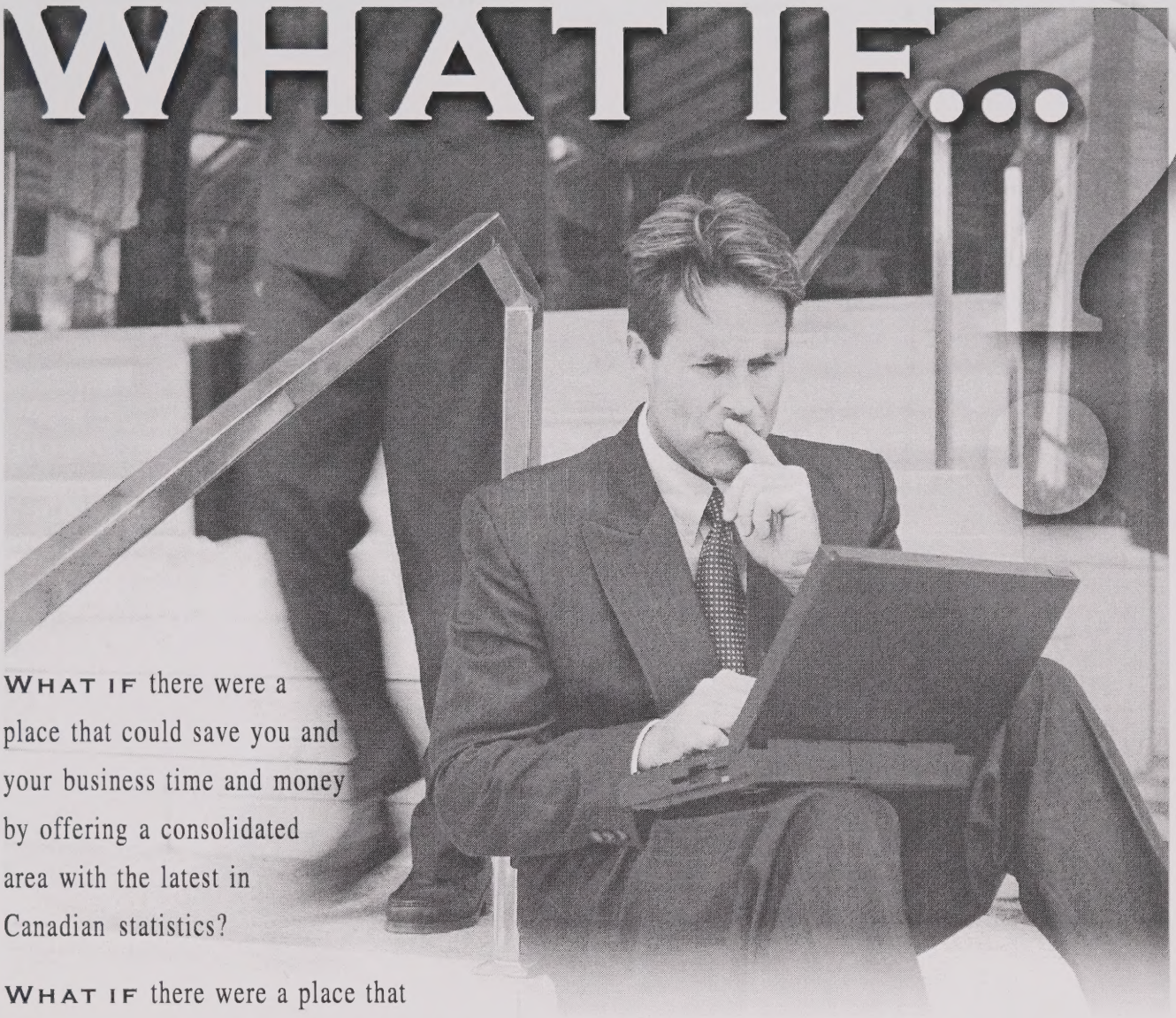

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